A Diphtheria Immunization Campaign in Austria*

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DURING the past 4 years Austria has suffered an unusually high incidence of diphtheria, but the case fatality rate has been extremely low. The province of Burgenland, which forms the eastern boundary of the Republic, has been particularly affected, as hospitals are few and far between, and the cost of antitoxin is in many cases prohibitive.†

In 1925 diphtheria preventive measures received a definite setback in Austria following 6 fatal accidents in Baden bei Wien.[1] The use of toxin-antitoxin was prohibited by government decree. In 1932, by authorization of the Austrian Superior Medical Council, the Bezirk Eisenstadt,‡ in the Province of Burgenland, where diphtheria was prevalent, and where no immunizations had been done, was set aside as a field where the newer methods of prophylaxis could be investigated. The primary object was to study the epidemiology of diphtheria and to demonstrate the harmlessness of formol-toxoid injections and their protective value.

The Bezirk Eisenstadt has a well organized health unit under the direction of a full-time health officer, and has served as a demonstration health unit since 1929. The staff of physicians and nurses is so organized as to facilitate follow-up work. As will be seen from Figure I, the diphtheria morbidity rate in the bezirk in 1932 was extremely high, 764 per 100,000 inhabitants. The case fatality was low, about 2.5 per cent, and there were very few severe cases. Austria as a whole shows a similar picture, with a considerable increase in the morbidity rate from 1930 to 1932, the highest since 1894.

The Burgenlanders are primarily agricultural, but their dwellings are almost entirely in closed villages. In these communities the housing conditions are in many instances as unhygienic as those in the most densely populated sections of Vienna; there is much overcrowding, and extreme poverty. The population of the Bezirk Eisenstadt according to the 1923 census was 42,010, concentrated almost entirely in 29 compact villages.

The high prevalence of diphtheria, with the disease occurring first in one village and then in another, has put a heavy financial burden on the communal governments and sickness insurance companies. There are no communicable disease hospitals in the district, and the cost of transporting the

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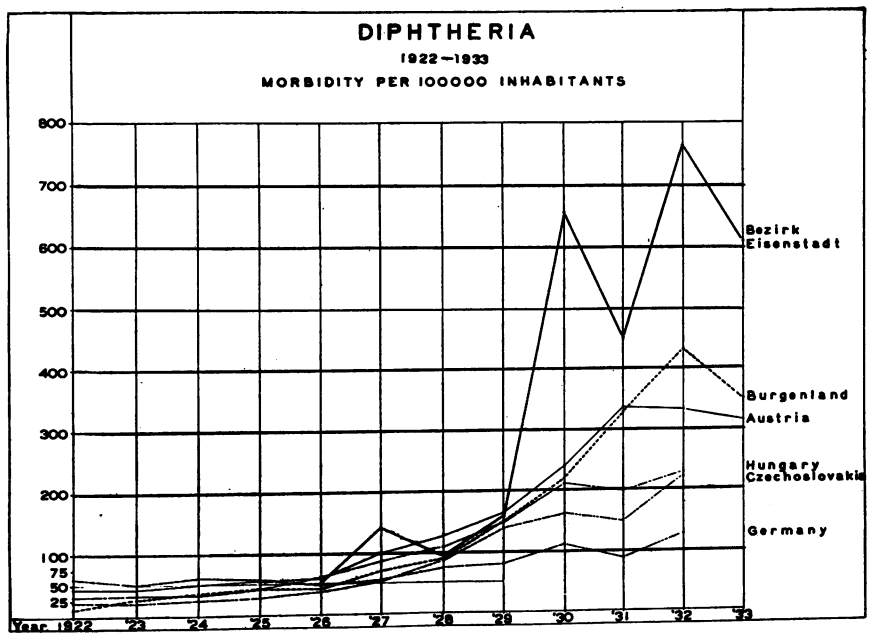
† Antitoxin retails at Sch. 3.80 ($.70) per 1,000 unit lots. In quantities of 10,000 units it costs Sch. 35.00 ($6.48).

‡ The bezirk corresponds to the American county.

FIGURE I—Comparison of the diphtheria morbidity rate for the Bezirk Eisenstadt with the rate for the Province of Burgenland and rates for Austria, Hungary, Czechoslovakia, and Germany, during the period 1922–1933



sick to those in neighboring bezirks has been considerable.

Since 70 per cent of all cases of diphtheria were being reported among children 2 to 8 years of age, inclusive, it was decided to concentrate on this group with our program of immunization. The following plan was adopted:

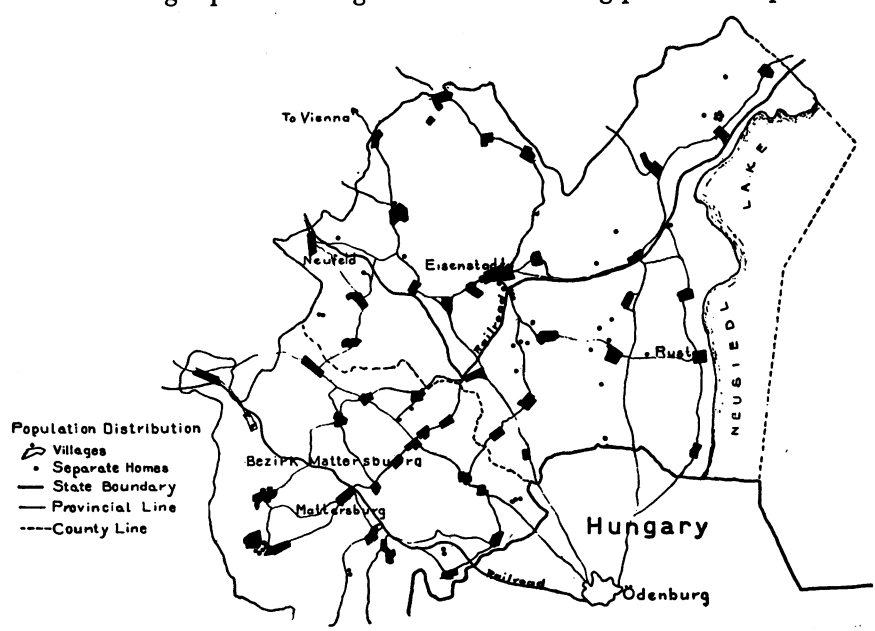
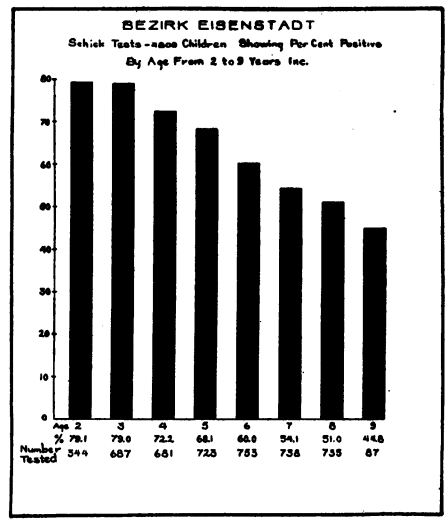


FIGURE II—Bezirk Eisenstadt

1. Perform Schick tests on, and take nose and throat cultures from, as many children as possible in the age group 2 to 8 years inclusive.
2. Read Schick tests 4 days later and administer 0.5 c.c. of formol-toxoid (8 fl. units) to each alternate Schick positive child, the remaining Schick positive children to be left as a control group.
3. Administer 1.0 c.c. of formol-toxoid 11 to 14 days after the first injection.
4. Administer 1.5 c.c. of formol-toxoid 11 to 14 days after the second injection.
5. Make virulence tests on all diphtheria cultures obtained from carriers.
6. Perform second Schick tests on as many immunized children as possible.
7. Take blood samples (5.0 c.c.) from a certain number of children in each village at the time of the second Schick test, and titrate the serum for antitoxin content as a parallel to the Schick test.

A card index was prepared including every child in the bezirk between 2 and 8 years of age, of whom there were 5,173. Of this number 4,879 appeared for the preliminary examination. Later, 4,809 were present for the Schick reading, of whom 3,096 were found to be positive. Of the Schick positives 1,746, or 56.4 per cent, were given 3 injections (3 c.c. total) of formol-toxoid. Of 2,006 children who received the first injection 1,746, or 87.0 per cent, completed the series. This high percentage was made possible through the excellent collaboration of the population and the local health authorities. The percentage of children receiving 3

FIGURE III—Percentage of Schick positive children, by ages, among a total of 4,809 tested



injections is generally much lower, and the efficiency of the 3 injection method is thus being markedly diminished. The campaign was inaugurated in May, 1933, and ended in August of the same year.

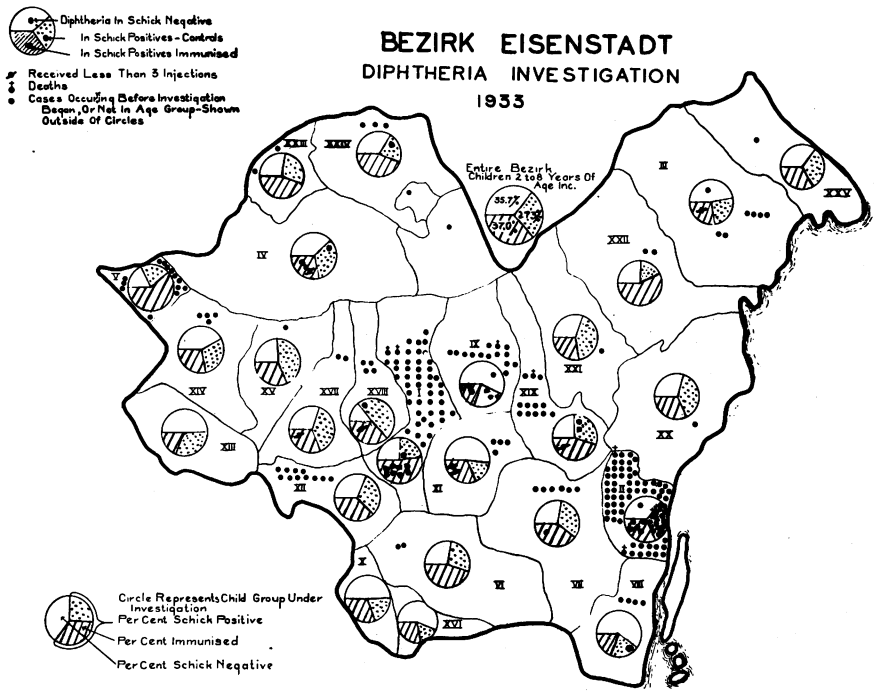
The toxin used for the Schick test is a product of the State Serum Institute in Vienna and complies with the international standard.[2] The immunizing material was formol-toxoid (8 fl. units), produced by the State Serum Institute and was supplied gratis. The formol-toxoid was injected subcutaneously over

TABLE I

REACTIONS TO FORMOL-TOXOID INJECTIONS

	Redness		*Redness Induration Slight Fever*		*Redness Induration Fever*	
Age	*Number*	*Per Cent*	*Number*	*Per Cent*	*Number*	*Per Cent*
2	3	2.0	0	0	0	0
3	5	1.6	0	0	1	0.3
4	7	2.2	3	0.9	0	0
5	9	2.8	3	0.9	1	0.3
6	14	4.9	7	2.4	0	0
7	8	3.2	4	1.6	0	0
8	15	6.3	7	3.0	0	0
Total	**61**		**24**		**2**	

FIGURE IV—Incidence of diphtheria in the Bezirk Eisenstadt during the period from the beginning of the campaign, in May, 1933, to December 31, 1933



the left deltoid in 0.5 c.c., 1.0 c.c., and 1.5 c.c. amounts at intervals of 11 to 14 days. All Schick tests and readings were made by 2 young physicians who had received special preliminary training in the work at the University Kinderklinik in Vienna. No severe reactions occurred. Table I shows the frequency and severity of reactions among the group immunized.

Of the group of 1,746 children receiving 3 injections 4.6 per cent showed reactions according to the foregoing classification. The age distribution is given below.

Reactions by Ages

Age	*Number*	*Per Cent*
2	3	2.0
3	6	1.9
4	10	3.1
5	13	4.0
6	21	7.3
7	12	4.8
8	22	9.3

TABLE TO FIGURE IV

TOWNSHIP	Number of Children Tested	Per Cent	
		Schick Positive	Immunized
I Eisenstadt	418	73.7	52.2
II Rust	195	64.1	31.8
III Purbach	269	52.8	27.1
IV Hornstein	275	62.2	28.0
V Neufeld	240	81.3	60.0
VI Siegendorf	262	72.5	45.8
VII St. Margarethen	274	72.3	40.1
VIII Mörbisch	289	40.1	18.3
IX St. Georgen	122	43.4	19.7
X Zagersdorf	161	50.3	31.1
XI Trauersdorf	187	48.7	32.1
XII W. Prodersdorf	244	68.9	37.7
XIII Zillingtal	117	50.4	18.8
XIV Stinkenbrunn	169	57.4	27.8
XV Müllendorf	100	76.0	32.0
XVI Klingenbach	166	44.0	27.7
XVII Gross Höflein	179	70.4	31.3
XVIII Klein Höflein	95	86.3	36.8
XIX Oslip	120	75.9	45.8
XX Oggau	211	70.6	32.2
XXI Schützen	140	69.3	27.9
XXII Donnerskirchen	179	74.3	56.4
XXIII Wimpassing	98	72.4	44.3
XXIV Leithaprodersdorf	131	65.6	44.3
XXV Breitenbrunn	168	64.5	33.3
Total	4809	64.3	37.0

Second Schick tests were done on 596 children in 8 villages from 10 weeks to 7 months after the third injection of

formol-toxoid. Of these, 44, or 12.6 per cent, remained Schick positive, and 552, or 87.4 per cent, were Schick negative after 3 injections.

Blood samples were taken from 213 children at the time of the second Schick test. The results of antitoxin titration as compared with Schick results will be reported later.

Complete results from the carrier survey are as yet not available. Of the 9,237 nose and throat smears examined, 124 gave positive results; and of these, 21 proved to be virulent on animal tests.

In each village every practising physician was furnished with a list of children in his community, showing results of Schick tests, those immunized, and results of second Schick tests on the latter. This served to stimulate their interest and assisted greatly in the reporting and follow-up of new cases.

TABLE TO FIGURE V

Township	Number of Children Tested	Per Cent	
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FIGURE V—Incidence of diphtheria in the Bezirk Eisenstadt from January 1 to May 1, 1934

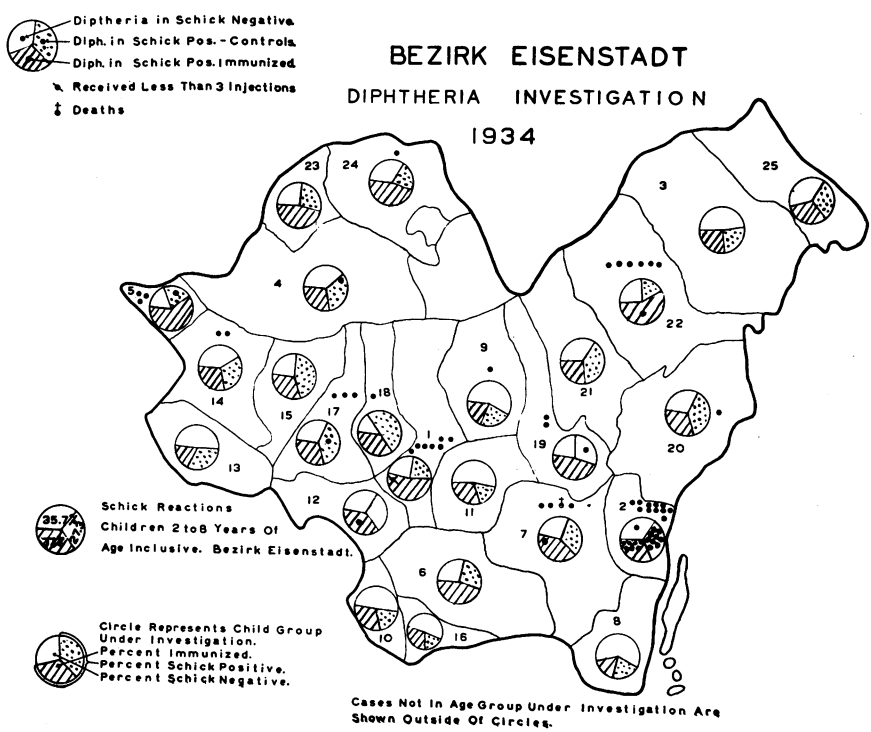

TABLE II

INTERVAL BETWEEN THIRD INJECTION OF FORMOL-TOXOID AND ONSET OF DIPHTHERIA IN 29 CHILDREN

Case Number	*Interval*	*Case Number*	*Interval*
6	21 days	101	5 months
12	29 "	112	5 "
23	42 "	138	5 " 12 days
37	2 months, 25 days	169	5 " 29 "
107	3 "	134	6 " 25 "
97	3 " 6 "	188	6 "
39	3 " 15 "	146	7 "
133	3 " 28 "	150	7 "
52	4 "	177	7 "
116	4 " 2 "	181	7 " 5 days
92	4 " 5 "	182	7 " 5 "
56	4 " 6 "	183	7 " 18 "
96	4 " 7 "	192	9 " 8 "
137	4 " 8 "	194	9 " 22 "
67	4 " 10 "		

It is approximately a year since the campaign was inaugurated, and it is interesting to note the results of immunization with a formol-toxoid of low antigenic value after this length of time. Diphtheria has continued to be very prevalent. The spot maps show the occurrence of the disease, Figure IV from the beginning of the campaign in May, 1933, to the end of the year, and Figure V from January 1 to May 1, 1934.

The village of Rust (see Figure II), population 1,361, presents a particularly interesting situation. During the past 12 months 97 cases of diphtheria have occurred, of which 12, or 19.4 per cent, were in the group having 3 injections of formol-toxoid (3 c.c. total). Of the total immunized in the entire district, 29, or 1.66 per cent, contracted the disease. It is evident that, in the face of a severe epidemic, and in spite of the fact that 92.6 per cent of the children were rendered Schick negative by the 3 injections of formol-toxoid, the antigen used offered an inadequate means of protection. While 29 cases occurred among the "immunized" children, there were only 37 in the control group. All cases of diphtheria occurring among the children who had received the 3 injections of antigen were very mild, while among the unimmunized children, 11 deaths were recorded, of which 4 were in the control group.

SUMMARY AND CONCLUSIONS

In a rural county of eastern Austria, with an unusually high incidence of diphtheria, 1,746 children 2 to 8 years of age inclusive, out of a total of 3,096 Schick positives, were given 3 injections of formol-toxoid (8 fl. units). During the year following the inauguration of the campaign, 29 cases of diphtheria occurred among those, and 4 among children giving a Schick negative reaction.

The antigen employed was apparently of too low potency to protect against diphtheria when used in the presence of an epidemic of unusual intensity. The severity of the disease was modified in those who had received 3 injections (3 c.c. total) of antigen.

REFERENCES

1. Grassberger, R. *Arch. f. Hyg.*, XCVII:97, 1926, and *Lancet*, II:1,074, 1926.

2. *Report of the Permanent Commission on Biological Standardization: Series of League of Nations Publications, III. Health*, III, 10, 1931.